Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/471
GERMANY, FEDERAL REPUBLIC OF
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

HARDENING OF FACE CENTERED CUBIC METALS DUE TO REACTOR IRRADIATION

J. Diehl, Max-Planck-Institut für Metallforschung, Stuttgart
W. Schilling, Laboratorium für technische Physik der Technischen Hochschule, München

The present paper gives a survey on some recent experimental work on the changes of the mechanical properties of f.c.c. single crystals due to fast neutron irradiation in a nuclear reactor. It is similar in scope to the contribution of one of the authors (J.D.) to the IAEA Symposium on Radiation Damage in Solids and Reactor Materials, Venice, 1962. However, the present report is based on more detailed results and covers a more extended series of experiments, including irradiations at ambient reactor temperature as well as irradiations at helium temperatures, normal tensile tests, creep test, measurements with changes in temperature and strain rate and electron microscope studies of slip lines. The low temperature experiments were carried out in the low temperature irradiation facility of the Munich Research Reactor. The main results are the following:

(a) Low temperature irradiation and post-irradiation annealing experiments support the view that the increase of the yield stress in heavy f.c.c. metals, like copper, is caused by radiation induced depleted zones, which impede the motion of dislocations, as originally proposed by Seeger.

(b) The annealing behaviour of the yield stress of aluminium after irradiation at low temperature is different from that of copper. It can be accounted for by the assumption that primarily single point defects dispersed in the lattice act as obstacles to the motion of dislocations. Apparently in this metal depleted zones are not formed or are less stable than in copper.

(c) Neither in copper nor in aluminium indications for a source hardening mechanism (locking of the dislocation sources by point defects) could be obtained from yield stress measurements.

(d) The saturation effects, revealed by the dose dependence of the yield stress of Cu, are almost independent of the irradiation temperature (between 4° and $300^{\circ}K$). The saturation is in accordance with measurements of the electrical resistivity and can be accounted for by athermal radiation annealing processes.

(e) For a more comprehensive interpretation of the temperature and strain rate dependence of the yield stress of the heavy metals, a size distribution and possibly deviations from a random arrangement of the depleted zones have to be taken into account.

(f) Further evidence of the previously reported differences in the deformation behaviour of heavy metals after low and high irradiation doses has been obtained by various experimental techniques. These differences can be interpreted in a tentative way.